

NOTE: ALL INFORMATION IN BLACK IS STANDARD VERBIAGE; INFORMATION IN BLUE INDICATES PROJECT SPECIFIC INFORMATION

4M—STRUCTURES AND AESTHETICS

4M.1 GENERAL

Design and construct all structures and aesthetics systems in accordance with the requirements of this specification, including performance requirements, standards and references, warranties, design and construction criteria, maintenance during construction, and required submittals. The {Insert: PROJECT NAME / DESCRIPTION} Project shall include the following list of structures:

{List each bridge structure with the following information as appropriate}

1. The bridge description, e.g. “a new interchange bridge” or “a replacement bridge for the existing UPRR overpass”
2. The bridge location, e.g. “at 11400 South and I-15” or “at approximately 1650 West along SR-77”
3. The seismic design performance level for each bridge, e.g. “Seismic Design Performance Level will be “Normal” (MCE – 2% PE in 50 years, “life safety”)
4. The parapet crash level minimum, e.g. “Parapet crash level minimum of TL-4”
5. If applicable, provide the following statement – “See Part 8 – Engineering Data – 11.01, 10.09 Bridge Data for plans developed previously for this structure. Note that these drawings are provided in metric units”.

{List each non-bridge structure with the following or similar explanation}

1. Retaining wall structures as required. “Coordinate these needs with Part 4 D – (Geotechnical) and Part 4 K – (Roadways)”.
2. Sign structures as required. “Coordinate these needs with Section 4L Signs”.
3. Drainage related minor structures as required may need to be either replaced, extended, or added. “See Part 4 – B (Drainage) for description and performance requirements”.

Have the flexibility to make project changes that produce benefits or savings to the Department or the Design-Builder without impairing the essential functions and characteristics of the Project, such as safety, traffic operations, durability, desired appearance, maintainability, environmental protection, drainage, and other permitted constraints.

The requirements in this specification apply to the design and construction of temporary and permanent structures, including bridges, walls, barriers, moment slabs, sign structures, luminaires, traffic signals, and major drainage structures such as box culverts, structural plate arches, and precast concrete arches. The alternate technical proposal may be used to request Departmental approval to modify requirements of this RFP.

4M.2 STANDARDS AND REFERENCES

4M.2.1 Standards

Design and construct the structures and aesthetics systems in accordance with the relevant requirements of the standards listed by priority in Table 4M-1.

If there is any conflict in standards, adhere to the standard with the highest priority; however, if the Design-Builder's Proposal has a higher standard than any of the listed standards, adhere to the Proposal standard.

If there is any unresolved ambiguity in standards, it is the Design-Builder's responsibility to obtain clarification from the Department before proceeding with design and/or construction.

Use the most current version (including interims) of each listed standard as of the initial publication date of this RFP unless modified by addendum or change order.

TABLE 4M-1
STANDARDS FOR STRUCTURES AND AESTHETICS

<i>Priority</i>	<i>Author or Agency</i>	<i>Title</i>
*1	Design-Builder	Contract for { Name of Project }
2	UDOT	<i>Request for Proposals, {Name of Project} (including performance specifications and Project special provisions)</i>
3	UDOT	<i>2008 Standard and Supplemental Specifications</i>
4	UDOT	<i>2008 Standard Drawings</i>
5	AASHTO	<i>AASHTO Load Resistance Factor Design (LRFD) Bridge Design Specifications (Customary U.S. Units), 4th edition</i>
6	AASHTO	<i>Standard Specifications for Highway Bridges</i>
7	AASHTO	<i>Guide Specifications for Horizontally Curved Steel Girder Highway Bridges</i>
8	AASHTO	<i>A Policy on Geometric Design of Highways and Streets</i>
9	AASHTO	<i>Guide Specifications for Design and Construction of Segmental Concrete Bridges, 2nd edition</i>
10	AASHTO	<i>Guide Specifications for Design of Pedestrian Bridges</i>
11	AASHTO	<i>Guide Design Specifications for Bridge Temporary Works</i>
12	MCEER/ATC 49	<i>Recommended LRFD Guidelines for the Seismic Design of Highway Bridges</i>
13	AASHTO	<i>Standard Specifications for Highway Signs, Luminaries and Traffic Signals,</i>
14	AASHTO / AWS	<i>Bridge Welding Code, D1.5M/D1.5: 2002</i>
15	AASHTO	<i>Guide Manual for Condition Evaluation and Load Resistance Factor Rating (LRFR) of Highway Bridges</i>
16	AREMA	<i>Manual of Recommended Practice</i>
17	UPRR	<i>Guideline for Design and Construction of Grade Separation Underpass Structures</i>

**Only to the extent that it exceeds another listed Standard.*

4M.2.2 References

Use the references listed in Table 4M-2 as supplementary guidelines for the design and construction of the structures and aesthetics system. These references have no established order of precedence.

TABLE 4M-2
REFERENCES FOR STRUCTURES AND AESTHETICS

<i>Author or Agency</i>	<i>Title</i>
AASHTO	<i>Guide Specifications for Structural Design of Sound Barriers</i>
AASHTO	<i>Guide Specifications for Seismic Isolation Design</i>
AASHTO	<i>LRFD Bridge Construction Specifications</i> , 2nd edition
AREMA	<i>Manual for Railway Engineering</i>
ATC	<i>Improved Seismic Design Criteria for California Bridges</i>
BNSF/UPRR	<i>BNSF Railway-Union Pacific Railroad Guidelines for Railroad Grade Separations Products</i>
FHWA	<i>Drilled Shafts</i> , FHWA-IF-99-025.
FHWA	<i>Drilled Shafts for Bridge Foundations</i> , FHWA-RD-92-004
FHWA	<i>Mechanically Stabilized Earth Walls and Reinforced Soil Slopes Design and Construction Guidelines</i> , Demonstration Project 82, Ground Improvement, FHWA-NHI-00-043
FHWA	<i>Corrosion/Degradation of Soil Reinforcements for Mechanically Stabilized Earth Walls and Reinforced Soil Slopes</i> , FHWA-NHI-00-044
UDOT Engineering Services Division	<i>Life Cycle Cost Analysis, Value Engineering</i>
UDOT Structures Division	<i>Design and Detailing Standards</i>
UDOT	<i>Environmental Impact Statement Record of Decision</i> , June 2005
UDOT	<i>Structures Design Quality Plan</i>
UDOT	<i>Structures Design & Detailing Manual</i>

4M.3 PERFORMANCE REQUIREMENTS

Design and construct all new structural components necessary to provide a complete and functional system that meets the following performance requirements:

- A. Provide functionality, durability, ease of maintenance, safety, and aesthetics;
- B. Design all permanent structures for a 75-year service life per AASHTO and in accordance with seismic stability requirements;
- C. Meet the traffic performance requirements as stated in the performance specification for roadway;
- D. Limit structural settlements in accordance with the performance specification for geotechnical;
- E. Incorporate all aesthetic commitments in accordance with the environmental document and agreements; and
- F. Provide a surface smoothness for bridge decks and approach slabs in accordance with Section 01452 (Pavement Smoothness).

Accommodate all cross street typical sections given in Part 7—Concept Plans.

4M.4 DESIGN AND CONSTRUCTION CRITERIA

4M.4.1 Materials

4M.4.1.1 Concrete

- A. Structural Components: For concrete in structural components, meet the following minimum requirements:
1. *Cast-in-Place Concrete:* Class AA(AE); see Section 03310 (Structural Concrete);
 2. *Precast Concrete:* Class AA(AE); see Section 03310 (Structural Concrete); Type III cement may be used;
 3. *Prestressed Concrete:* Class AA(AE); see Section 03412 (Prestressed Concrete);
 4. *Bridge Decks and Approach Slabs:* Class AA(AE); see Section 03310 (Structural Concrete);
 5. *Filling Postholes of Post-and-Panel Noise Walls:* Class B(AE);
 6. *Piles, Drilled Shafts, and Slope Protection:* Class A(AE); and
 7. *All Other Bridge, Box Culvert, Wall, and Barrier Components:* Class AA(AE).
- B. Concrete Decks: Use UDOT AA (AE) concrete with the following additional requirements as outlined in this section
1. Fly Ash and or Silica Fume are traditionally acceptable by the Department as pozzolans used for cement replacement. Use of other pozzolans is subject to review by the engineer for approval prior to mix design submittal. Limit the use of silica fume to 5% of total weight of cementitious material;
 2. Limit the water-to-cementitious material ratio to 0.4; and
 3. Limit concrete shrinkage to 0.032 strain based on ASTM C490, "Determination of length of Change of hardened Cement Paste, Mortar, and Concrete".
- C. Sealing:
1. Seal all bridge columns, bent caps, abutment seats, and parapets; see Section 03392 (Penetrating Concrete Sealer);
- D. Light Weight Aggregate:
1. Use furnace-surface-sealed and coarse nonreactive lightweight concrete aggregate, per AASHTO M 195 for lightweight concrete.
- E. Strength:
1. *Minimum Specified Concrete Strengths:* See Standard Specification Sections 02861 (Precast Retaining/Noise Walls), 03055 (Portland Cement Concrete), 03310 (Structural Concrete), 03412 (Prestressed Concrete); and 03339 (Full Depth Concrete Deck Precast Panel).
 2. *Maximum Specified Concrete Strengths for Design:*

- a. Cast-in-place: $f'_c = 5$ ksi;
- b. Pre-stressed: $f'_c = 8.5$ ksi. (This may be increased through the UDOT alternate technical proposal process); and
- c. Lightweight: $f'_c = 5$ ksi.

4M.4.1.2 Prestressing Steel

- A. For prestressing steel in structural components, meet the following requirements for minimum spacing of prestressing steel strands:
 - 1. For 0.6-inch strands: 2 inches; and
 - 2. For 0.5-inch strands: 1.75 inches.
- B. Use low-laxation strand that comply with AASHTO M203 Grade 270 from plants certified by the Precast/Prestressed Concrete Institute (PCI);
- C. Design prestressed concrete members using AASHTO losses and without transforming reinforcing or prestressing steel; and
- D. Debonding of prestressing strands is allowed; however, do not debond more than 25% of the total strands or more than 40% in any row.

4M.4.1.3 Post-Tensioning Steel

- A. For post-tensioning steel in new structural components, provide corrosion protection consisting of grout-filled galvanized or nonmetallic ducts; use a prepackaged grout that contains a minimum of 5% silica fume by weight of cementitious materials.
- B. Unbonded and external tendons may be used on rehabilitation projects with the Department's approval through the UDOT alternate technical proposal process.

4M.4.1.4 Reinforcing Steel

For reinforcing bars in structural components, meet the following requirements:

- A. Use reinforcing steel conforming to AASHTO M31 ($F_y=60$ Ksi), except as noted below.
- B. Use steel deformed bars, conforming to ASTM Designation A706, for substructure elements. Internal bent caps, where design load will exceed elastic limits and where plastic hinges may form, are included in the above specified substructure elements.
- C. Use bars that are uncoated corrosion resistant, hot-dip galvanized after fabrication, or epoxy-coated, per Standard Specification Section 03211, Reinforcing Steel and Welded Wire, except for bars used in caissons or piles.
- D. For minimum concrete cover, comply with AASHTO LRFD Bridge Design Specifications, except as noted. For concrete exposed to weather, use a minimum cover of 2 inches with an allowable construction tolerance of $(+)^{1/4}$ inch. In decks that do use an initial concrete bridge deck overlay (2"), use a minimum cover of 1½ inches to top bars with an allowable construction tolerance of $(+)^{1/4}$ inch. For bridge decks that require grinding, use a minimum cover of 2½ inches after grinding.

GFRP may be substituted for reinforcing steel in bridge decks.

4M.4.1.5 Structural Steel

- A. For structural steel, use AASHTO M270, Grade 36, Grade 50, or Grade 70 and paint in accordance with Standard Specifications Section 05120 (Structural Steel). Weathering steel may be used over a

stream, with a clearance greater than 8 feet over the design moving water surface elevations and a 10-foot clearance over stagnant sheltered water. Ensure that the girders can air-dry from any water spray or high-water events.

- B. The maximum change in thickness or gross cross-sectional area of any web or flange plate at any splice is a factor of two.
- C. When using unpainted weathering steel, paint girder ends and expansion bearings a minimum of one and one-half times the girder depth; and provide drip plates at the low side of all deck expansion joints for all girders and at the high side of all abutments and bents for exterior girders.

4M.4.2 Steel Plate Size Parameters

- A. The minimum plate dimensions for new structural steel are as follows:
 - 1. Thickness of any steel girder flange plate: 1 inch;
 - 2. Thickness of any steel plate or shape to which shear studs are welded: ½ inch;
 - 3. Thickness of any girder stiffener or web plate: 3/8 inch;
 - 4. Minimum width of any girder flange: 10 inches; and
 - 5. Bottom flange of steel plate girders: Constant width per frame.
- B. Provide shear connectors that penetrate at least 3 inches into the slab and are not less than 3 inches from the top of the slab. Do not place shear studs on splice plates, except to comply with AASHTO minimum spacing requirements. Extend shear studs the full length of the girders and support diaphragms to help transfer seismic forces to the supports.
- C. On new structures, do not use cover plates, pins, or hangers.
- D. Do not field-weld to girders without Department approval, except for bearing sole plates.
- E. Provide steel diaphragms within 10 feet of the centerline abutment bearings.
- F. For structural steel field splices, use direct-tension indicator washers; follow Section 05120 (Structural Steel).
- G. For all miscellaneous steel items permanently cast into structural concrete elements, use either galvanized steel, stainless steel, or other approved coatings.

4M.5 DESIGN

Design structures in accordance with AASHTO *LRFD Bridge Design Specifications*, except as otherwise noted herein. Design structures carrying, adjacent to, or over railroad tracks in compliance with the requirements of the American Railway Engineering and Maintenance-of-Way Association (AREMA) and other railroad-specific requirements.

Place as-built quantities on the first sheet of the Structure Situation and Layout for End-of-Project submittals.

In all retaining wall designs, address internal stability, external stability, liquefaction, and seismic loading.

4M.5.1 Loads and Forces

Determine all structure loads and forces in accordance with the AASHTO LRFD Bridge Design Specifications or the AASHTO design specification applicable to the structure type.

- A. Live Loads: HL-93.

- B. Dead Loads: Add a unit dead load of 35 pounds per square foot (psf) to all bridge structures for future overlay.
- C. Wearing Surface: Include a ½-inch initial sacrificial wearing surface. This sacrificial wearing surface is included in the clearance requirements indicated in section 4M.4.1.4.
- D. Load Rating: Load-rate all bridges using methods described in the AASHTO *Guide Manual for Condition Evaluation and Load Resistance Factor Rating of Highway Bridges*. Design all structures such that the final inventory load rating is greater than or equal to 1.00 for HL-93 loads. Place both inventory and operating ratings on the first sheet of the bridge Situation and Layout Sheet.
- E. Uplift: The Department prefers bridges that avoid uplift; therefore, proportion the bridge spans to avoid uplift at supports due to non-seismic loads. Always consider the presence of uplift at the ends of continuous girders, particularly with light rolled beams or short end spans. See *LRFD Bridge Specifications* for appropriate load factors. Uplift restraints, when used, must satisfy the strength limit state and the fatigue and fracture limit state.
- F. Thermal Forces: Design for moderate-climate temperature ranges in accordance with AASHTO *LRFD Bridge Design Specifications*.
- G. Earthquake Response: Design all new bridges for seismic forces resulting from the earthquake response corresponding to 2 percent exceedance in 50 years. See “Design Seismic Accelerations” in Part 4 – D (Geotechnical), 4D.8. for the determination of design spectral accelerations for horizontal ground accelerations. Design all retaining walls in accordance with requirements in “Retaining Walls and Earth Embankments” in the geotechnical performance specifications. In all cases, design retaining wall panel or block connections to not fail during a seismic event corresponding to an exceedance probability of two percent in 50 years.

4M.5.2 UDOT Structure Numbers

Obtain from the UDOT Structures Division a UDOT structure number for each permanent bridge, retaining wall, overhead sign structure, and major drainage structure such as a box culvert or headwall. Modifications of existing structures also require a new UDOT drawing number. Cast the structure number into the structure concrete in accordance with standard UDOT details.

4M.5.3 Plan Organization and Content

Provide structure design plans that comply with the following:

- A. Provide structure design plans that include all design details necessary to construct the structure. This includes, but is not limited to, conduit, inserts and attachments, the location of lighting fixtures attached to the structure, and approach slab drains. For structures where design details are developed and provided by a supplier (such as mechanically stabilized earth [MSE] retaining walls and structural plate arches), include the supplier’s design drawings as part of the final structure plan set.
- B. Use the standard UDOT Structures Division border and title block on all plan sheets. Replace the State Bridge Engineer signature with the signature of the Design-Builder’s Structure Design Manager. Supplier-detailed drawings that are included in the final plan set may use the supplier’s border and title block.
- C. Provide Situation and Layout plan sheets for all bridges, box culverts and rigid frame drainage structures, retaining walls, and noise walls. Provide Situation and Layout plan sheets that meet the requirements in the “Situation and Layout Sheet Requirement Check List” included in the UDOT Structures Division *Design and Detailing Standards*.

- D. Separate the structure plan sheets from all other discipline sheets in the plan set and organize them by UDOT structure number.
- E. When corridor standard plans are used to replace details typically included in the structure plan set, include the applicable corridor standard plan sheets with each structure plan set and list them in the Index of Sheets on the Situation and Layout Sheet.
- F. Include in the bridge plan set a soil-boring location plan and the soil-boring logs used in the geotechnical design of the bridge.
- G. Organize the plan sheets in the bridge plan set in the general order of construction.
- H. Include in the final retaining wall plan set a location plan showing the location of all retaining walls pertaining to the structure number. Include for each individual retaining wall the situation and layout plans prepared by the designer and the detailed drawings prepared by the wall supplier. Include aesthetic treatment in supplier drawings.

4M.5.4 Design Calculations

4M.5.4.1 Organization

Organize the final design calculations and independent review calculations as follows:

- A. Title page with bridge number, bridge name, “Design Calculations” or “Independent Review Calculations,” designer’s name and professional engineer (PE) stamp;
- B. Table of contents;
- C. Signed and stamped Design QC/QA Certification Forms for structure designs;
- D. Seismic Strategy Memorandum;
- E. List of any deviations from Project design criteria;
- F. The appropriate code references, as necessary;
- G. References to computer programs, with appropriate code section indicated;
- H. Computer documentation, including program name, vendor, version, and release date; and
- I. Bridge Load Rating Report and calculations.

4M.5.4.2 Paper and Numbering

- A. For handwritten calculations (both handwritten and computer-generated) and sketches, use standard letter-sized paper; and
- B. Number all pages with a numbering scheme that covers the entire set of calculations for each volume.

4M.6 AESTHETICS

4M.6.1 Performance Requirements

- A. Prepare an initial aesthetics plan based on criteria in this Section;
- B. Develop a revised plan that integrates landscaping and aesthetic treatments; and
- C. Design and construct aesthetic treatments that:

1. Are aesthetically pleasing and fit the neighboring environment,
2. Are in accordance with the aesthetic commitments that have been made, and
3. Respond to the coordination with the cities along the alignment.

4M.6.2 Design and Construction Criteria

- A. *Aesthetic Theme:* Propose a Project-wide aesthetic and landscaping theme, then coordinate with and gain approval of the theme from the Department. Coordinate this theme with the local municipalities, and offer them the opportunity to sponsor betterments that complement this theme.
- B. *Structural Elements:* The Project structural elements include, but are not limited to; all bridge components, retaining walls, and noise walls. Paving includes colored, stamped permanent pavement in parkstrips, in accordance with the UDOT Standard Drawings.
- C. *Visual Context:* Consider the visual context in designing the aesthetic treatment of a structural element. Use aesthetic treatments that employ the use of color and texture, then further express them via pattern reveals, bevels, shadow lines, surface finishes, and geometric form work.
- D. *Scale and Proportion:* The quality of views to the structures are influenced by the form of the structural components, the balance between span length and structure depth, avoidance of bulky appearance, and the continuity between bridge supports (both piers and abutments) and the superstructure. The scale and proportion of a bridge are important influences on its aesthetic quality.
- E. *Aesthetic Treatment Elements:* When designing the aesthetic treatments, incorporate the following elements:
 1. Integration of the aesthetic treatment with the landscape design;
 2. Continuity of the visual treatments within the limits of each city;
 3. Consistency of graphic art, signage, lighting, and architectural treatments;
 4. Relief, form, and proportion of structures within the Project;
 5. Use of texture and color to define aesthetic treatments;
 6. Views of structural elements from outside the ROW, Intersection, and adjacent land uses;
 7. Safety concerns (in Project design and construction),
 8. Ease of maintenance and repair; and
 9. Deterrence of vandalism and graffiti; and
 10. Incorporate decorative elements to the cut and fill walls and sound walls, such as painting or patterning of the concrete.
- F. *Aesthetic Treatment Factors:* When designing the aesthetic treatments, incorporate the following factors:
 1. Accentuating the span length;
 2. Use of parabolic haunches at bents (piers) for continuous girders;
 3. Controlling the apparent structure depth;

4. The interface of approach walls with bridge abutment and deck;
 5. The proportional relationship of deck cantilever to girder depth;
 6. Treating linear elements along a bridge (such as barrier rails, deck edge, and girder face) with color and texture;
 7. Treating light blisters along bridge barrier rails with form, color, and texture;
 8. The shape and treatment of bents (piers) and abutments with form, reveals, color, and texture that relate to other bridge elements and identify the bridge as part of the visual character of the neighborhood or city; and
 9. Treating slope protection between bridge abutment and roadway paving, as it relates to the abutment and bridge structure.
- G. Maintenance: Use aesthetic treatments that are low maintenance and include a maintenance agreement from municipalities.
- H. Retaining and Noise Walls: For vertical surfaces of both retaining and noise walls, apply aesthetic treatment where the surface is visible to the motorist and the trail user and from the adjacent ROW. For both retaining and noise walls, use a consistent treatment that articulates the design themes established by the bridge aesthetic treatments and landscape design. Use pattern, texture, color, fenestration, reveals, scoring, caps, shadow lines, and other architectural treatments to create visual interest. Design the proposed treatment to be a part of the wall, regardless of the type of wall construction. Treat walls along both sides of the alignment uniformly.
- I. Medians and Parkstrips: Apply aesthetic treatment to paving of medians between curbs and parkstrips between the curb and sidewalk. Use aesthetic treatments such as colored concrete or imprinted patterns. Refer to Part 4 –E Landscape for landscaping requirements associated with aesthetics.
- J. Stain: Apply a penetrating stain to all retaining walls, noise walls, roadside, and median barriers throughout the Project and to the following bridge elements: exterior girders, parapets, abutments, wingwalls, and intermediate supports. Ensure stain is compatible with the selected sealer.

4M.6.3 Aesthetic Treatment Maintenance

- A. Defects, Flaws, and Vandalism: Note defects, flaws, or damage from vandalism and bring them to the Department's attention.
- B. Defect and Flaw Repair: Repair defects and flaws in the aesthetic treatment of structural elements during the construction period and up to the FOA as required per the discussion of nonconforming work in Part 3—Quality Program.
- C. Vandalism Damage: Clean up any damage caused by vandalism during the construction period and up to the FOA.

4M.6.4 Aesthetic Submittals

Aesthetics Plan: After coordinating with the cities and the Department and before submitting any Project Plans, provide an Aesthetics Plan to the Department for approval. The plan will detail all interrelationships between structural components and landscaping (See Part 4 – E (Landscape)), including the colors and textural treatments applied to these elements.

4M.7 BRIDGES

4M.7.1 Bridge Geometry

- A. Cut-and-Fill Slopes: Limit the steepness of all cut-and-fill slopes adjacent to bridges to 1.5:1 (horizontal: vertical). Slopes steeper than 2:1 require concrete slope protection. For new bridges, place a two-foot level area between the top of slope and the front of the abutments to facilitate inspection access.
- B. Vertical Clearances: Provide the following minimum vertical clearances for all new structures:
 - 1. Highway grade separations: 16.50 feet;
 - 2. Bridges over railroads: 23.50 feet;
 - 3. Non-redundant structural elements at highway and railroad grade separations, including post tensioned (P/T) bent caps: An additional 1.00 feet; and
 - 4. Pedestrian overpass structures: 17.50 feet.
 - 5. Bridges over rivers: Provide a 2'-0" minimum freeboard clearance at Q_{50} and ensure the water surface elevation is not raised more than 1'-0" at Q_{100} when considering the backwater effects of the structure.
- C. Bridge Supports: Protect all bridge supports from vehicular collision as required by AASHTO LRFD Bridge Design Specification 3.6.5.1. Design to the requirements of AASHTO LRFD 3.6.5.2 only when it is deemed totally impractical to meet the requirements in AASHTO LRFD 3.6.5.1. When determining the required horizontal distance between a roadside barrier and bent columns and caps, consider barrier deflection and the potential for trucks with a high center-of-gravity to lean over the barrier, as described in the AASHTO *Roadside Design Guide* 5.5.2 and 5.6.1.
- D. Curved Bridges: Design horizontally curved bridges in accordance with the AASHTO *Guide Specifications for Horizontally Curved Highway Bridges*. Use HL-93 live loading. Where practical, locate supports radially for curved structures.
- E. Bridge Skew: Where practical, design the bridge with a maximum bridge skew less than or equal to 30 degrees. Bridges skewed more than 45 degrees require either a finite element or grillage method of analysis.
- F. Bridges with Median Parapet: Where a bridge includes a median parapet, provide a longitudinal joint in the center of the median parapet to separate the cross-section into two bridges.

4M.7.2 Bridge Type

- A. Use bridge types and components that utilize prefabricated bridge elements that facilitate accelerated bridge construction practices and innovative bridge techniques.
- B. The following bridge types are traditionally used by the Department:
 - 1. Prestressed concrete I-girders with a cast-in-place concrete deck, and
 - 2. Structural steel I-girders with a cast-in-place concrete deck.
- C. The following bridge types are not commonly used by the Department, but may be used when appropriate.
 - 1. Concrete Slab Span; and
 - 2. Precast Prestressed Rectangular Beam with cast-in-place deck.

- The Department will consider these bridge types upon reviewing a proposal describing the benefits, potential cost savings, and examples of its use.
- D. The Department will not consider timber or masonry bridges.
 - E. Bridge types not traditionally used by the Department may be used, but only when it is shown to benefit the Department. For the Department to consider nontraditional bridge types, supply information in the proposal that demonstrates the following for concept review:
 - 1. The bridge type or element has been successfully used by other transportation authorities, as supported by specific project contact information;
 - 2. The bridge type and components will perform well under the environmental conditions of the Project, including frequent freeze-thaw cycles and heavy road salt use;
 - 3. The design will allow the bridge deck to be completely removed and replaced if determined deficient by the Department. Removal and replacement will occur with minimal impact on cross-traffic. Minimal impact is defined as slightly lower speed or narrower lanes or slight lane shifts resulting in a traffic delay of less than 5 minutes;
 - 4. The bridge meets all possible other requirements contained in this structures and aesthetics Section. If a requirement cannot be met, other methods will be utilized to accomplish the same results. A written explanation will be required for all RFP requirements that cannot be met, and Department approval is required before the RFP requirement can be waived;
 - F. The Department uses large quantities of salt and de-icing chemicals in the winter, which accelerate corrosion of bridge structures; address this concern in bridge design and construction; and
 - G. Incorporate as few deck expansion joints as possible. Make bridges continuous over supports, and use integral or semi-integral abutments wherever possible. When expansion joints are required, locate them at supports.

4M.7.3 Seismic Requirements

- A. Use the multimode spectral analysis method for all bridges except single-span bridges. For single-span bridges, including bridges with integral abutments, use the single-mode spectral analysis method. Provide adequate gap between barriers and structural elements such as columns and retaining walls to accommodate the design seismic movement.
- B. Provide minimum bridge seat widths for expansion bearings that accommodate the larger of (a) the displacements predicted by the mode analysis, and (b) the minimum seat width requirements of MCEER.
- C. Develop a seismic strategy for each bridge type. Include descriptions of expected damage, the locations of plastic hinging, the redistribution of forces, the mobilization of backfills, and the function of bearings, as appropriate.
- D. Provide adequate moment and shear connections in accordance with the joint shear requirements of MCEER. Design the vertical acceleration of cantilever and outrigger supports in accordance with MCEER.

4M.7.4 Inspection Access

- A. Make all bridge superstructures, expansion joints, backwalls, enclosed compartments, and bearings accessible for long-term inspection by direct viewing. Make expansion joints accessible for direct viewing from the underside of the joint. For expansion joints at abutments, provide inspector access

between the end diaphragm and the backwall to allow inspection of the backwall and the underside of the expansion joint by direct viewing.

- B. Make open-framed superstructures accessible with walkways or ladders, or by use of a snooper truck. When the bridge crosses a river or railroad tracks or cannot be reached by a 25-foot ladder, provide clearances for the snooper truck. Provide a cable anchorage system to facilitate inspections when elements subject to inspection cannot be accessed using a 25'-foot ladder. When the snooper truck is to be used for inspection, the total height of the parapet and fencing must be 10 feet or less. The horizontal distance from the edge of shoulder to the edge of deck must be less than 10 feet.
- C. Box girders with an inside depth of 5 feet or more require access through the box girder for interior inspection. In all box girders, provide an opening that is at least 3 feet by 3 feet, has a hinged metal door that swings into the box girder, and has a removal bolt for locking. Where required, provide a method of ladder support for inspection access. Prevent public access behind the diaphragms on seat-type abutments. Use a chain link type fence between the exterior girders and cheek walls with an access gate that has a removal bolt for locking.

4M.7.5 Bridge Components

- A. Bridge Parapets. Provide bridge parapets that are consistent with the performance specification for roadways. Use a 42-inch-high, single-slope parapets on bridges and approach slabs. Transition to roadway barriers on the roadway section, not on the approach slabs. On bridges that carry pedestrian traffic, provide fencing using details in accordance with Standard Drawing FG6, "Chain Link Fence." The fence may be upgraded as a betterment to the cities. Provide one 3-inch and one 1½-inch spare conduit in each outside parapet on all bridges. For bridges that carry interstate traffic a minimum test level criteria will be TL-4. For all other non-I-15 mainline bridges use minimum test-level criteria of TL-3 for bridge and approach railings (parapets).
- B. Approach Slabs: At the end of each bridge, provide an approach slab that is at least 25 feet long (measured along the control line of the bridge), is the same width as the bridge deck, and extends over the abutment wingwalls. Make allowance for settlement between the approach slab and wingwall, providing a minimum gap of 5 inches between the top of the wingwall and the approach slab. Provide for expansion and contraction at the approach slab to pavement interface. Use a sleeper slab and a joint type that accommodates the maximum anticipated movement times 1.5. For single span bridges use a joint that accommodates the movement of the entire bridge, assuming the full movement may occur at the joint at either end. For the sleeper slab configuration, provide an inverted "TEE" shape with a bottom slab width of 5'-0". For skews at the approach slab to pavement interface greater than 20 degrees, and where the roadway pavement structural section surface is Portland Cement Concrete Pavement, provide a stepped joint or other means of preventing lateral movement of the approach slab due to expansion and contraction. When a stepped joint is used, match step widths to those defined by Standard Drawing PV-2.
- C. Deck Systems. The following deck systems are traditionally used by the Department:
 - 1. Bridge constructed in a staging area and moved into its final position:

- a. 8" cast-in-place concrete deck in staged construction area;
 - b. Provide 2 1/2" clear cover for top mat of reinforcing steel;
 - c. Provide 1" clear cover for bottom mat of reinforcing steel;
 - d. Empirical deck design is not allowed; and
 - e. Provide a Thin-Bonded Polymer overlay.
2. Full-Depth Precast Concrete Deck Panels
- a. 8 3/4" (including a grinding allowance of 1/4"; hence a final thickness of not less than 8 1/2".) full depth precast concrete deck panels;
 - b. Provide 2 3/4" clear cover for top mat of reinforcing steel (before grinding);
 - c. Provide 1" clear cover for bottom mat of reinforcing steel;
 - d. Provide longitudinal post-tensioning of precast panels; and
 - e. Provide a Thin-Bonded Polymer overlay. See 4M.7.5 (H) for the required timing of the application of this overlay.
 - f. Use the Longitudinal Post-Tensioning (LPT) method of connecting the deck panels.
3. Partial Depth composite precast concrete deck panels:
- a. Partial depth precast concrete deck panels;
 - b. Total deck thickness (panels + structural deck) is 8" or greater;
 - c. Provide 2 1/2" clear cover for top mat of reinforcing steel;
 - d. Provide 1" clear cover for bottom mat of reinforcing steel; and
 - e. Provide a Thin-Bonded Polymer overlay. See 4M.7.5 (H) for the required timing of the application of this overlay.
4. Segmental concrete systems and concrete box girders:
- a. Includes all superstructure types in which the slab integrated with the superstructure;
 - b. Provide 8" minimum deck thickness;
 - c. Provide 1 1/2" clear cover for top mat of reinforcing steel;
 - d. Provide 1" clear cover for bottom mat of reinforcing steel; and
 - e. Provide an initial concrete bridge deck overlay (2" thick). Do not provide a Thin-Bonded Polymer overlay for this deck system.
5. Other Deck systems are subject to approval through the Alternative Technical Concepts approach outlined in Section ITP.3 (Alternative Technical Concepts).

Additional Requirements:

- The interface between the deck and approach slab requires a formed construction joint.
- Provide a complete and detailed deck replacement plan for each bridge type that allows the deck to be completely removed and replaced with minimal impacts on cross-street traffic.

- See Section M4.1.1.B (concrete) of this specification for deck slab concrete requirements.
- D. Drain Pipes: Paint drain pipes to match the color of the adjacent structural members. Extend drains below the superstructure and, where feasible, extend down substructure elements to an outlet at ground level unto slope protection or rip-rap basin.
- E. Expansion Joints: Where possible, avoid or minimize expansion joints. Eliminate expansion joints in bridges shorter than 360 feet, unless the bridge is skewed more than 30 degrees. Use only strip seal or modular for expansion joints other than those occurring at the sleeper slab or for sleeper slab expansion joint movements in excess of 2½ inches. In the design and location of joints, provide for maintenance accessibility and future replacement. Do not use aluminum joints. Design modular joints for high-cycle fatigue loading.
- F. Deck Overlays: Provide an initial concrete bridge deck overlay (2" thick) when using segmental systems and concrete box girders. Acceptable overlay types include dense-bonded, low-slump concrete, latex-modified concrete, and silica-fume concrete. Provide a Thin-Bonded Polymer overlay such as epoxy or polyester on all concrete bridge decks except when using an initial overlay (2" thick) deck overlay. Do not consider concrete overlays as part of the structural component of the deck. Extend overlays to include approach slabs.
- G. Concrete Deck Overlays: Cure all concrete overlays in accordance with the requirements for bridge decks in Section 03390 (Concrete Curing) and "Guidelines for Bonded Concrete Overlays," TB-007P, American Concrete Pavement Association;
- H. Use a Thin-Bonded Polymer overlay except when using an initial concrete bridge deck overlay. For interstate bridges use a Thin-Bonded Polymer Type I overlay. Use a Thin-Bonded Polymer Type II overlay for non-interstate bridges. Apply the overlay on the concrete deck after grinding. Extend overlay to include approach slabs.
1. For bridge decks and approach slabs constructed prior to January 21, apply the Thin-Bonded Polymer overlay after May 15 of the same calendar year. For bridge decks and approach slabs constructed after January 21, apply the Thin-Bonded Polymer overlay after May 15 of the following calendar year.
 2. For bridges constructed and moved into place where the operation of moving the bridge either requires the bridge to be supported more than 36 inches from the staged support point, or if tensile stresses may occur during the movement or setting of the bridge, apply the Polymer overlay within 30 days of setting the bridge in its final location, as an exception to the dates specified above.
- I. Limit live load deflections to 1/1000 of span length for bridges that carry pedestrian traffic and 1/800 for all other bridges. Do not use steel box girders with an inside depth that is less than five feet as fracture-critical members.
- J. Provide sufficient internal post-tensioning for segmental box girders to support dead loads and a minimum of 0.5 live load for a design seismic event.
- K. For graffiti protection, provide flange guards on all steel and concrete exterior girders that are accessible without a ladder to prevent pedestrian access along the exterior girders. Install steel plate flange guards on exterior steel plate girders where necessary. Provide steel guard plates or concrete guard blocks to the tops of exterior concrete girder bottom flanges flatter than 45 degrees.
- L. All personnel grouting post-tensioning ducts must be American Segmental Bridge Institute (ASBI) or PCI -certified as a grouting technician.

- M. Do not place utilities on structures unless no reasonable alternative exists. Refer to Administrative Rule R930-6. Utilities placed on structures require the approval of the Department and a design by a Utah-licensed Professional Engineer. If utilities must be placed on a structure, hide them from view. Do not attach utilities to the visible exterior of the superstructure.
- N. Design and locate bearings to provide for maintenance accessibility and future replacement. Elastomeric bearings are the preferred type. For sole plates, provide a minimum thickness of $\frac{3}{4}$ inch. At expansion bearings, do not permit the edge of the sole plate to slide past the edge of the elastomeric pad. Provide at least 6 inches of cover between anchor bolts and the edge of the concrete pedestal. Reinforce pedestals taller than 3 inches. Seismic isolation bearings are acceptable.
- O. Make the type of pier cap consistent with the bridge system and aesthetic strategy proposed for the Project. The Department will accept drop caps or internal caps, but prefers integral caps when concrete box section systems are used. The use of integral steel pier caps is not permitted without Department approval. The Department will approve the use of integral steel pier caps only when no other alternative exists; if they are used, provide interior inspection access. Protect pier caps and columns from weathering steel staining during construction.
- P. Unless a bridge is skewed more than 30 degrees, use integral or semi-integral abutments for structures up to 360 feet long. Do not use MSE walls to support abutments. Use wingwalls at all abutments.
- Q. Provide concrete slope protection for all bridges with spill-through abutments, except where riprap is required for hydraulic reasons. Make slope protection consistent with the aesthetic plan and in accordance with details in the UDOT Structures Division *Design and Detailing Standards*, Standard Drawing "Concrete Slope Protection."
- R. Use approved deep foundations per the geotechnical performance specifications.
- S. For drainage, see the performance specification for drainage. Intercept roadway drainage in advance of the bridge.

4M.7.6 Maintenance Plan

Provide a maintenance plan for each bridge type used, as follows:

- A. Describe routine maintenance procedures as well as items specific to all components of the bridge type.
- B. Include a detailed list of all maintenance and rehabilitation work, and the number of times each procedure is to be anticipated over the 75-year structure life (itemized by the year in which the procedure is to be performed).
- C. Make the items on this maintenance list the same as those that would be used for life-cycle costs.

4M.8 WALLS

4M.8.1 Retaining Walls

4M.8.1.1 Approved Wall Systems

The following wall systems are acceptable for use as permanent retaining walls on the Project:

- A. UDOT-approved mechanically stabilized earth (MSE) wall systems;

- B. Cast-in-place concrete retaining walls; and
- C. Soil nail walls.
- D. Prefabricated Modular Gravity Wall (PMGW) Systems.

4M.8.1.2 Other Wall Systems

- A. The following wall systems are acceptable only when the approved wall systems will not meet design requirements:
 - 1. Concrete crib wall: Not allowed within 50 feet of bridges; and
 - 2. Wire-enclosed riprap (gabions) of limited height: At stream banks only.
- B. Other wall systems may be used if they meet the same criteria as the alternate bridge types, excluding bridge deck replacement and life-cycle cost analysis. The approved and other wall systems are acceptable provided that the wall can accommodate the anticipated total and differential settlements for the life of the structure.
- C. Do not use bin walls or permanent wire-face wall systems.

4M.8.1.3 General

- A. Address slope maintenance above and below the wall in the retaining wall layout. At retaining wall ends, where possible, provide returns into the retained fill or cut.
- B. Consider surface and subsurface drainage in design and construction. Refer to the performance specification for drainage. Provide a system to intercept or prevent surface water from entering behind walls.
- C. Where access is open to the public, provide a pedestrian railing and protection as listed in UDOT Standard Drawing DD9.
- D. Provide a minimum clear distance of three feet between precast wall panels or blocks and bridge abutments. Place concrete slope protection between the wall and abutment.

4M.8.1.4 Seismic Requirements

See Section 4M.5.1 (Loads and Forces) in this performance specification for seismic criteria.

4M.8.1.5 Wall Characteristics

- A. MSE Walls: See the geotechnical performance specifications Part 4D - Geotechnical.
- B. Cast-in-Place Concrete Walls: Design and construct cast-in-place concrete walls in accordance with AASHTO LRFD Bridge Design Specifications. Account for differential settlement in the construction joint spacing. The Department will accept the standard concrete retaining walls shown in the UDOT Structures Division *Design and Detailing Standards*, Standard Drawings. Account for global stability as described in the geotechnical performance specifications.
- C. Soil Nail Walls: See the geotechnical performance specifications.
- D. Concrete Crib walls: May be used when other wall types will not meet design requirements. Provide concrete coping at top of wall.
- E. Wire Enclosed Riprap (Gabion) Walls: Acceptable for use adjacent to streams only when other wall types cannot meet all design requirements. Height is limited to 15 feet unless approved by the Department.

- F. Temporary Retaining Walls: Bear sole responsibility for the type, material, performance, and safety of temporary retaining structures. Design temporary structures supporting excavations or embankments such as sheeting or bracing by a Registered Professional Engineer licensed in the State of Utah in accordance with AASHTO *LRFD Bridge Construction Specifications (Section 3)* to meet all requirements of the State and the U.S. Occupational Safety and Health Administration (OSHA). The Department reserves the right for oversight review of these structures.

4M.8.2 NOISE Walls

Design and construct noise walls in accordance with AASHTO *Guide Specifications for Structural Design of Sound Walls*. Design noise walls for an 80-mph wind with additional 30-mph gusts. Meet final constructed tolerances of 0.25 inch in ten feet for level and plumb. Satisfy the project noise study for height and grade changes. Provide for adequate surface drainage in the design of noise walls. Use wall types that have been successfully used in geotechnical similar locations and environmental conditions.

4M.8.2.1 Geometry

When placed behind barrier, offset noise walls a minimum of five feet from the barrier; except across bridges, transitioning from bridges, or where it would be necessary to purchase right-of-way to meet this requirement.

4M.8.2.2 Components

- A. Construct panels of reinforced masonry blocks, bricks or concrete. Do not allow bricks to come in contact with soil. Use a cap for brick and masonry block. Panels may be cast-in-place or precast. When using concrete panels, use full-height panels. Use cast-in-place concrete panels when placing noise walls on bridges or longitudinal structural elements. Design and construct panels for ease of replacement and/or repair.
- B. Use reinforced concrete, prestressed pile, or galvanized steel H-pile posts.
- C. Use foundations of posts set in concrete, caissons, or cast-in-place or precast reinforced concrete footings. Place the bottom of all spread footing foundations a minimum of three feet below finished grade. Uncoated reinforcing steel may be used for caissons.

4M.9 SIGN, SIGNAL, AND LIGHTING STRUCTURES

- A. Design and construct structures for signs, signals, advanced traffic management systems (ATMS), variable message signs (VMSs), and lighting in accordance with UDOT Standard Drawings and AASHTO *Standard Specifications for Structural Supports for Highway Signs, Luminaries, and Traffic Signals*.
- B. Provide a minimum vertical clearance of 17.5 feet from the highest point of the road surface to the bottom of any sign panel.
- C. For loadings, consider the natural period of vibration from vortex shedding and upward wind pressures from passing trucks. Use Fatigue Category I for overhead sign structures and lighting supports taller than 98 feet; use Fatigue Category II for all other structures.
- D. Use galvanized structural steel tubing for overhead sign structures.
- E. Use drilled shafts to support overhead and cantilever sign structures. Use only cast-in-place retaining walls to provide vertical support for sign and lighting foundations. Isolate sign and lighting loads from all other wall systems.

- F. Make connections with A325 bolts. Make shop splices and base connections with full-penetration butt welds. Galvanize all connection hardware. Strengthen structural tubing at electrical connection openings.
- G. Do not mount signs on bridges unless no alternative exists.

4M.10 DRAINAGE STRUCTURES

Design and construct all drainage structures in accordance with AASHTO *LRFD Bridge Design Specifications*.

4M.11 SUBMITTALS

Submit the following to the Department:

4M.11.1 Initial Project Submittals

- A. List of computer software used in structural design;
- B. Project structure design criteria; and
- C. Aesthetics Plan.

4M.11.2 Review Submittals

- A. Plans and special provisions with aesthetic treatments;
- B. Design checklists;
- C. Completed Design Certification Forms per *UDOT Structures Design Quality Plan*;
- D. Documentation verifying completion of independent review; and
- E. Foundation recommendations Memos.

4M.11.3 Release for Construction Submittals

- A. Sealed Plans and special provisions with aesthetic treatments;
- B. Approved shop drawings; and
- C. Formwork and shoring drawings (sealed).

4M.11.4 Final Design Submittals

- A. Sealed Plans and specifications with aesthetic treatments (hard copy and electronic files (.pdf);
- B. Approved Aesthetics Plan;
- C. Sealed final design calculations;
- D. Sealed independent review calculations;
- E. Sealed bridge load ratings;
- F. Sealed Maintenance Plan for each bridge type;
- G. Sealed Seismic Strategy Memorandum for each bridge;
- H. Sealed Detailed Deck Replacement Plan; and

- I. Electronic files of Plans (MicroStation) and specifications (Microsoft Word)

4M.11.5 End-of-Project Submittals

- A. As-Built Plans (hard copy Adobe Acrobat – PDF format, and electronic MicroStation files);
- B. All field changes and field change calculations organized by structure; and
- C. Final approved shop drawings.

4M.12 WARRANTY

Warrant structures and aesthetics work in accordance with Part 9—Warranty Provisions.

4M.13 MAINTENANCE DURING CONSTRUCTION

Maintain existing and new structures during construction in accordance with the requirements in the performance specification for maintenance during construction (Part 4, Appendix 4G).